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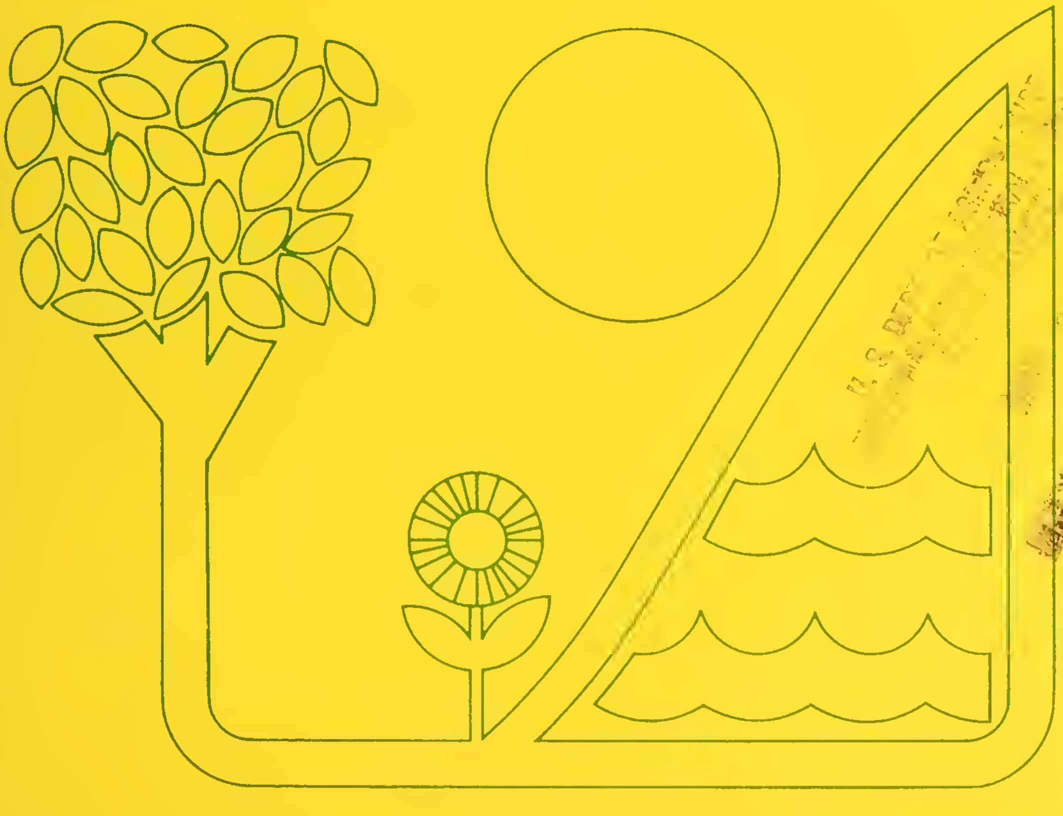

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CROPLAND NOT FOR HARVEST --- WHAT IS IT AND HOW IS IT USED?

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FOR DISCUSSION ONLY

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Abstract

A significant proportion of cropland in the U.S. is annually allocated to uses not leading to harvest, including cropland pasture. Not much is known about the interaction of those physical, economic, and institutional factors affecting decisions to establish and sustain cropland pasture, a seemingly lower use of available cropland. Using county data from the 1969 Agricultural Census weighted by farm numbers, preliminary analyses of the association between the incidence of cropland pasture in Kentucky and variables such as livestock numbers, type of farm, and land tenure were developed by multiple regression. These efforts are preliminary since analyses of Census data do not generate insights into the decision-making processes resulting in using a portion of available cropland as cropland pasture. These insights, however, are integral to estimating land use changes in response to changing economic and institutional conditions.

Key Words: Cropland pasture, Land use, Resource allocation.

Summary

Based upon the 1969 Census of Agriculture, about 40.5 percent of total cropland in the Census year was reported in one of the Cropland Not for Harvest uses. These uses include acres of cropland summer fallowed, idled, in soil improvement crops, and in cropland pasture. Comparable estimates by the U.S.D.A. Conservation Needs Inventory (CNI) Committee and the Statistical Reporting Service (SRS) are substantially below the Census estimate. Differences in survey procedures, land use definitions, and survey dates complicate any evaluation of the relative merits of these alternative sources of data.

Acres in cropland pasture account for a significant proportion of the Cropland Not for Harvest acreage. An understanding of the physical, economic, and institutional factors causing decision makers to allocate land, which is by definition cropland, to cropland pasture is important in estimating land use adjustments in response to changes in these factors. County data for Kentucky weighted by number of farms in respective counties were incorporated into models for estimating the associations between acres in cropland pasture and independent variables such as land resource areas, livestock numbers, and type of farm. These associations were estimated through multiple regression. Despite deriving acceptable statistical "fits" for the models, no causality between the variables can be inferred. Rather, a survey of farmers to collect primary data on the factors embodied in land use decisions is necessary for understanding current land-use patterns, the opportunities for and flexibility of shifting cropland in Cropland Not for Harvest uses to Cropland for Harvest, and the factors constraining and inducing these shifts. Analyses of Census, CNI, and SRS data cannot provide this information.

Cropland Not for Harvest --

What Is It and How Is It Used?

Roger W. Hexem*

Each year, a substantial portion of cropland in the U.S. is allocated to uses not leading to harvest. These uses include cropland summer fallowed, idled, in soil improvement crops, and in cropland pasture. According to the 1969 U.S. Census of Agriculture, 40.5 percent of total cropland was in these Cropland Not for Harvest categories in the Census year. 1/ While the above are, by definition, alternative uses of available cropland, the question arises as to whether this land should be considered the equivalent of land from which crops are harvested so that complete transference among alternative cropland uses can occur from one production period to the next. If differences in productivity and in the flexibility of land-use shifts are evident, these factors should be incorporated into land-use analyses. Acres summer fallowed, for example, generally have an associated time sequence during which land is brought into and then taken out of production. Idled cropland and cropland in soil improvement crops can presumably be returned to production immediately or within a short period of time. Acres in cropland pasture, on the other hand, are likely related to livestock numbers and, thus, partly dependent upon another set of factors affecting whether this cropland is pastured or planted to crops for harvest.

This Is an Important Question

Three principal sources of data on cropland in Cropland Not for Harvest categories are available. U.S.D.A. conducted inventories of land use and associated conservation needs in 1958 and 1967. 2/ The Statistical Reporting Service (SRS) has collected data on these cropland uses since 1967 through their annual June Enumerative Survey (JES). 3/

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1/ U.S. Dept. of Commerce, Bureau of the Census. 1969 Census of Agriculture, Vol. II. General Report, Chap. 2. Farms: Number, Use of Land, Size of Farm. June 1973.

2/ Conservation Needs Inventory Committee of the U.S.D.A. Basic Statistics of the National Inventory of Soil and Water Conservation Needs. Stat. Bull. 317. Aug. 1962.

________Basic Statistics -- National Inventory of Soil and Water Conservation Needs, 1967. Stat. Bull. No. 461. Jan. 1971.

3/ U.S. Dept. of Agr., Statistical Reporting Service. June Enumerative Survey. Unpublished data.

Finally, the Censuses of Agriculture generate land use data but only at five-year intervals. 4/ Because of differing survey procedures, definitions of land uses, and survey periods, land use data developed by the three sources are not strictly comparable. Moreover, procedures for making the data series comparable, if this is in fact possible, are not readily apparent.

Some dimensions of this problem can be demonstrated by reference to Table 1. Recognizing that the surveys cover only roughly comparable time periods but employ different survey procedures, data from the 1969 Census are considerably higher than data from the 1967 CNI and the 1968 and 1969 SRS June Enumerative Surveys. Acres reported as Cropland Not for Harvest in the Census were 61 and 29 percent above the 1969 SRS and 1967 CNI estimates, respectively. There is, however, some correspondence between, for example, the 1967 CNI and the 1969 Census acreages of Other Cropland Not for Harvest. Most variability occurs in estimates of cropland pasture. Which is the best, most reliable source of data? The CNI and SRS data are only reported at the state level. If county data are needed, the Agricultural Census or some other source must be used.

As noted earlier, the Cropland Not for Harvest categories represent a significant component of the total cropland base. Nearly 33 percent of the total cropland reported in the 1967 CNI was in these uses. In the 1969 Agricultural Census, about 40 percent of all cropland was in cropland pasture plus Other Cropland Not for Harvest. According to SRS, acreage in these uses in 1975 was considerably below the 1969 levels. Not much is known about the physical and economic viability of this cropland for production of field crops. Almost 78 percent of acres in Cropland Not for Harvest in the 1967 CNI was in land capability I III; this acreage also represented 25.7 percent of the reported total cropland. SCS considers soils in classes I-III suitable for regular cultivation of most field crops and for a wide range of other uses. 5/

The treatment of acres in summer fallow rotation is usually relatively straightforward. Considerably less is known about cropland pasture and idle cropland. One hypothesis is that this land is toward the margin of economic viability and comes into and goes out of Cropland for Harvest as economic conditions vary. The parcels of land may be small, fragmented and (or) of relatively low productivity. The rate

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4/ During 1840 to 1920, a national agricultural Census was conducted every 10 years and since 1920, every 5 years.

5/ CNI Committee. Basic Statistics -- 1967, p. 1.

Table 1. Acres in cropland uses, by designated source and year, United States

	CNI	SRS	SRS	SRS	Ag Census 1969	
	1967 a/	1968 b/	1969 b/	1975 b/	All Farms	Class 1-5 Farms
	. . . .	. . . .	1,000 Acres	. . . .	. . . .	. . . .
Total Cropland	437,583				459,048	417,430
Cropland Harvested		295,099	286,669	324,808	273,016	261,138
Cropland Not for Harvest[c]	144,303	106,446	115,721	62,534	186,032	156,293
"Cropland Pasture"	50,445[d]	24,684	30,683	20,841	88,221	69,006
Other Cropland Not for Harvest	93,858	81,762	85,038	41 693	97,811[e]	87,287[f]
(Summer Fallow)	(31,982)	(34,497)	(39,204)	(31,054)		(44,463)
(Soil Improvement)	(39,026)[g]	(24,419)	(22,508)	(864)		(14,838)
(Idle)	(11,239)	(22,846)	(23,326)	(9,775)		(23,461)
(Open land formerly cropped)	(11,611)					

Table 1 continued

	Ag Census 1964	
	All Farms	Class 1-5 Farms
	. . . . . 1,000 Acres	
Total Cropland	434,232	387,726
Cropland Harvested	286,892	267,841
Cropland Not for Harvest[c/]	147,340	119,885
"Cropland Pasture"	57,419	43,772
Other Cropland Not for Harvest	89,921[e/]	76,113[f/]
(Summer Fallow)		(35,490)
(Soil Improvement)		(23,053)
(Idle)		(12,449)
(Open land formerly cropped)		

[a/] CNI Committee, Basic Statistics -- 1967.
[b/] SRS June Enumerative Survey except Cropland Harvested acres from SRS Crop Production Annual Summaries.
[c/] Acres in "Cropland Pasture" plus Other Cropland Not for Harvest.
[d/] Includes cropland in grasses and legumes used for hay or pasture as part of the crop rotation.
[e/] Acreages of individual components are not reported.
[f/] Includes 4525 and 5121 acres subjected to crop failure in 1969 and 1964, respectively.
[g/] Identified as acres in "Conservation Use".

and timing of these land use changes should have important implications for economic analyses, especially producer responsiveness to changing economic conditions and (or) agricultural policies. Based upon the 1969 Agricultural Census, about 19.2 percent of all cropland was in cropland pasture. In order to estimate the U.S. Agricultural capacity to produce and to make projections of crops, livestock and their interrelationships, the features of cropland pasture must be known. Simply treating cropland pasture and idle cropland as components of total cropland having equivalency to acres of cropland harvested seems too convenient. If these lands are not immediately and fully shiftable to field crops, they should not be aggregated into a total cropland base but should be analyzed in terms of those factors causing this land to be used for other than field crops.

Problems in Evaluating the Comparability and Usefulness of Available Data

Some of these problems have already been identified. Of most importance are differences in procedures for generating the data and in definitions of some land use categories.

Survey Procedures

Identification of land uses and necessary conservation measures in the Conservation Needs Inventories were determined through field inspections of sample sites by SCS personnel. These sites were generated through a random sample survey design. After the sample data were expanded to county levels, the county data were analyzed by county Conservation Needs Inventory Committees and were adjusted if the data varied substantially from known values. State committees were also formed and charged to "Review and compare county CNI data for uniformity in method and consistency of estimates . . . Where estimates are inconsistent among counties or the procedures have not been followed, revisions will be required." 6/

The annual SRS June Enumerative Survey is a probability survey incorporating multiple frame sampling. The multiple frame construct results from using two sampling frames, an "area frame" comprising the

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6/ Department Conservation Needs Inventory Committee. U.S.D.A. National Handbook for Updating the Conservation Needs Inventory, August 1966, p. 6.

total land area within a survey domain and a "list frame" representing names of potential survey respondents. About .6 percent of land area within the U.S. is selected or sampled for JES enumeration. 7/ Trained enumerators ask the farm operator or other "knowledgeable people" a variety of questions, including a specification of all land uses within the sample unit (tract) as of around June 1 of the survey year. Survey sample responses are then expanded to state levels but are not subject to possible adjustment.

Since 1920, the U.S. Census of Agriculture has been conducted every 5 years. Prior to 1969, Census forms were mailed and then collected and reviewed and, at times, completed by enumerators. The 1969 and 1974 Censuses, on the other hand, were principally conducted by mail. Mailing lists were compiled from several sources; attempts were made to avoid duplications. Nonrespondents were contacted by a series of follow-up mail requests and, in some instances, telephone calls. The follow-up procedures focused on certain units ". . . to be sure that data were collected from the previously identified very large and(or) very complex operations." 8/ Because of differing survey procedures, some unspecified level of noncomparability exists between the 1969 and 1974 Censuses and the earlier Censuses conducted by field enumeration.

Levels of Aggregation

The CNI surveys generated detailed land use data for each state. Estimated acres in specified land uses were further disaggregated into "irrigated" and "nonirrigated" categories with cross-reference according to SCS land capability classes and subclasses. Land uses range from, for example, "row and close grown field crops" to "cropland temporarily idle" to forest land" and "other land". In addition to inventorying land uses as of survey dates, the corresponding conservation treatments ". . . needed to maintain or improve the soil and plant resources" 9/ were identified, again according to SCS land capability class and subclass. The final phase of the survey was ". . . to identify the small watersheds and the kinds and extent of flood-prevention and water-management problems

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7/ U.S.D.A., Statistical Reporting Service, June Enumerative Survey -- Supervising and Editing Manual. March 1974.

8/ U.S. Dept. of Commerce, Bureau of Census. 1969 Census of Agriculture. Vol. II. General Report, Chap. 1. General Information; Procedures for Collection, Processing, Classification. April 1973. p. 3.

9/ CNI Committee. Basic Statistics -- 1967. p. 1.

that can be solved only through project action". 10/

During 1969 through 1975, ERS contracted SRS to collect data on the individual Cropland Not for Harvest land uses. Land in permanent pasture and "farmstead, roads, ditches, woods, waste, etc." was also estimated. Acreages in these uses are reported for each state and for the U.S. A different approach, however, is planned for the 1976 JES. Questions relating to acres in summer fallow, permanent pasture, and "farmstead, . . ., etc." will be retained; those covering acres of cropland idled, in soil improvement crops, and cropland pasture will not be included in the 1976 survey. The thrust of the questions sponsored by ERS will rather reflect measurement of shifts in land use from Cropland Not for Harvest categories to cropland for harvest and conversions of permanent pasture, woodlands, and waste to cropland for harvest. Respondents will also be asked to look ahead and indicate any conversions to cropland or withdrawals from the cropland base planned or anticipated for the 1977 production year.

The agricultural Censuses, by definition, provide the most comprehensive inventory of farm characteristics, including land use. Data are summarized at the county, state, and national levels. Beginning in 1969, "long" and "short" questionnaires were used. The regular or "long" form was used for farms with an expected value of sales totaling $2,500 or more and the "short" form for farms with an expected value of sales of less than $2,500. On the short form, cropland used for soil improvement crops, crop failure, cultivated summer fallow, and idle cropland is reported in a composite category termed All Other Cropland". Individual estimates of these cropland uses are collected on the "long" forms, those completed by respondents on Class 1-5 farms. Consequently, county, state and national data are tabulated by two major groups: All Farms and Class 1-5 Farms, the latter providing the most detailed information.

Definitions of Cropland Not for Harvest Uses 11/

Summer fallow is essentially defined the same for the CNI, SRS, and Census surveys. The common principle is that the land was not seeded in the survey year thereby conserving moisture for the next production year but was periodically cultivated or worked in order to control weeds.

10/ Ibidem.

11/ The definitions are synthesized from the following sources: (CNI) CNI Committee. Basic Statistics -- 1967. (SRS) JES -- Supervising and Editing Manual. 1974; and (Census) 1969 Census of Agr. Vol. II. Chap. 2. 1973.

The Bureau of Census does not define idle cropland for respondents but asks them to report acres in "Cropland idle". 12/ Respondents on Class 1-5 Farms were also asked to report acres of "Cropland on which all crops failed", excluding orchards or vineyards subjected to crop failure. SRS, on the other hand, provides enumerators a rather detailed definition which basically includes: (a) cropland idled during the entire year, (b) acres previously plowed or plowable without clearing but which have been idle for more than one year, and (c) acres in orchards and vineyards where the trees and vines have been abandoned. Any acres in (c) would have been excluded from idle cropland in the Census. SRS also excludes from idle cropland those acres planted but which failed or were abandoned plus acres which were once cropland but are now so severely eroded that they could not be planted to crops. SCS makes a distinction between cropland "Temporary idle", which includes cropland in production or conservation use only at least one year during the three years before inspection, and cropland identified as "open land formerly cropped". The latter includes cropland idle for more than three years before inspection and which is not being converted to another use purposely.

The definitions of cropland used for soil improvement crops are comparable among the three surveys. This category would include cropland used for cover crops, legumes, and soil improvement crops plus any cropland diverted from other crops under federal programs. None of this land would be harvested, pastured, or summer fallowed.

Census respondents were asked to report any acres in cropland used only for pasture and grazing. No additional guidelines or definitions were provided. The SRS enumerators were asked to identify any acres in cropland used only for pasture which would include Cropland in rotation pasture and all other cropland used or to be used only for pasture or grazing in (survey year). This land could be used for crops without additional improvement". 13/ The following uses are excluded: land pastured before or after a hay crop was cut or other crops were harvested, native pasture or rangeland that has never been tilled but possibly could be plowed and used as cropland, and woodland or producing orchards grazed or pastured. Field inspectors for the CNI were asked to report cropland in Rotation hay and pasture which, in turn, was defined as "cropland in grasses and legumes used for hay or pasture as part of the crop rotation". Consequently, the

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12/ Operators of Class 1-5 Farms reported acres in "Cropland idle". The remaining farmers reported any such acres in "All Other Cropland".

13/ U.S.D.A., SRS, JES -- Supervising and Editing Manual, 1974, p. 57.

CNI definition would cover any acres reported in the Census and the SRS JES but, in addition, would include hayland which was part of a crop rotation system. Yet, acres reported as cropland pasture by Census respondents are substantially above acres reported by the other two sources.

Time Frames

The SRS annual June Enumerative Surveys are conducted in late May. Respondents report their actual or planned land use within the survey sample unit. Questionnaires for the 1969 Agricultural Census were mailed in fall, 1969. The follow-up procedures, however, continued into mid-1970. Late replying respondents lacking farm records would have had to recall information on the previous production year. Field work for the 1967 CNI was conducted in 1966 and 1967.

Data Reliability

Sampling rates for the SRS JES vary according to types of agricultural production in states. Sampling is less intensive in, for example, Western range areas. About 0.6 percent of the land area of the U.S. is selected for the annual JES enumeration. State and U.S. estimates of acres in the Cropland Not for Harvest categories represent direct expansions of the sample survey data. These estimates are not subjected to possible editing and adjustment by review committees. Standard errors and coefficients of variation (CV) corresponding to each of the estimated land uses are also derived. These are statistical measures of the reliability of the data generated. Lower CV's are, or course, preferred to higher values. Regional and U.S. estimates of acreages in the Cropland Not for Harvest categories in 1975 and associated standard errors and CV's are summarized in Appendix 1. In 1975, the CV for summer fallow, for example, was 2.3 percent for the U.S. with regional estimates ranging from 3.3 in the Northern Plains up to 92.5 percent in the Southeast Region. State CV's ranged from 4.2 up to 99.8 percent. The smaller the acreage and, thus, the more difficult to identify and to reliably measure, the higher the standard errors and CV's. When the CV is high, the estimated acreage is unreliable and should not be used in any analyses. Some additional problems seem to exist in the measure of cropland pasture. Even though acreages in the Southern Plains and Mountain Regions are rather sizeable, the CV's are also relatively high. An acceptable level of CV is somewhat judgemental. Certainly, a CV of 8.0 for cropland pasture at the U.S. level is acceptable; 34.0 for the Mountain Region is not.

The sampling rate for the 1967 CNI ranged from less than 1 percent up to 8 percent of the land area in each county. The basic sampling rate was 2 percent. This rate was calculated to give an "acceptable" degree or reliability in a county of 250,000 to 500,000 acres. In order to maintain the same degree of reliability in the data, the rate of sampling was reduced in larger counties and increased in smaller ones. Expansions of the sample point data to county levels were reviewed by county and state committees. "Data in error or in conflict with known values were adjusted." 14/ Also, "Where estimates are inconsistent among counties or the procedures have not been followed, revisions will be required." 15/ Consequently, the published data have been reviewed and adjusted, where necessary. Once the data have been adjusted, they lose their a priori statistical validity.

The reliability of the Census data is difficult to determine. The data can be checked for reasonableness against earlier Censuses and other data sources. The shift from enumerative to mail surveys, however, introduces a much greater incidence of sampling and non-sampling error. Mailing lists tend to be incomplete and outdated. In the mail inquiries, Census respondents also have considerable latitude in interpreting Census questions and in deciding the degree to which they provide accurate data on their farming operations. Coverage checks have been conducted for each Census of Agriculture since 1945. These checks are designed to provide indications of the completenss and accuracy of the Census data. The basic procedure used is to select an area sample, canvass all units in this area, compare Census responses with coverage check survey responses for individual units, and follow-up to check and clarify differences and establish "true" values. The coverage check procedure provides estimates of farms and acres (a) included in the Census, (b) overcounted in the Census, and (c) missed in the Census. The following quote summarizes major results of the coverage checks:

> ". . . 85 percent of all farms in the conterminous United States were included in the Census. Completeness of the Census in the North Central States was somewhat greater (90.5 percent) than in other regions. The United States total underenumeration is represented by a missed farm rate of 17.6 percent and an overcount rate of 2.6 percent for a net missed rate of 15.0 percent (in 1969). The estimated net missed rate for all farms was 11.3 percent in the 1964 Census and 8.4 percent in 1959. The missed farm rate for all farms with total value of products sold (TVP) $2,500 and over (in 1969) was 6.5 percent and overcount rate was 3.2 percent for a net missed rate of 3.3 percent. For farms with TVP of under $2,500, the missed

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14/ CNI Committee, Basic Statistics -- 1967, p. 203.

15/ Dept. CNI Committee, National Handbook for Updating the CNI, 1966, p. 6.

farm rate was 33.3 percent and the overcount rate was 1.7 percent for a net missed rate of 31.6 percent." 16/

Preliminary Analyses

The incidence and importance of land in the Cropland Not for Harvest categories were discussed earlier. Some of the problems in using available data were also outlined. In addition to the importance of generating reliable land use data, an identification of the factors causing cropland to be allocated to the Cropland Not for Harvest categories is important in forecasting future cropland use for any plans or programs of regional and state economic development. These factors affect the alternative uses of this land and, thus, the opportunity costs of current cropland use. If a determination were made that a portion of this cropland pasture, for example, was not suitable for field crops or suitable only with additional investment in the land, the cropland base should be adjusted accordingly to reflect these restraints or reservations on land which is, by definition, cropland.

Several hypotheses seem plausible. Small and (or) scattered tracts of cropland may not be viable under existing economic conditions and, therefore, reported as idle cropland or cropland pasture. Physical factors such as topography and changing productivity may cause farm operators to shift former cropland to Cropland Not for Harvest uses. At any point in time, some cropland would be expected to be idled because of adverse weather or shortages of production inputs. Agricultural policies have resulted in cropland being idled and (or) in soil improvement crops. Other institutional factors such as land tenure and type of farm would seem to affect land use decisions. Tenants, for example, might be hypothesized to use available cropland more fully and more intensively than owner-operators. Part-time and part-retirement operations might be expected to have more cropland in Cropland Not for Harvest uses than full-time operators.

Some of the above hypotheses were tested by estimating relationships among land use data and economic, physical, and institutional variables, as reported in the 1969 Agricultural Census. As with all data, the question of the representativeness and reliability of these data should be kept in mind. Cross-sectional analyses of county data for Kentucky were developed through multiple regression. Kentucky was selected for this preliminary analysis because of the high proportion of cropland being reported in the Cropland Not for Harvest uses, particularly cropland pasture.

16/ U.S. Bureau of the Census, Census of Agriculture, 1969, Vol. V., Special Reports, Part 16, Evaluation of Coverage, June 1974, pp. 6-7.

Table 2. Number of farms, total land in farms, and disposition of acres in cropland, Kentucky, 1969 and 1964.

	1969		1964	
	All Farms	Class 1-5 Farms	All Farms	Class 1-5 Farms
Number of farms	125,069	60,847	133,038	58,806
Land in farms (1,000 acres)	15,968	11,533	16,265	10,933
Total cropland (1,000 acres)	9,443	7,445	9,364	6 957
Cropland pasture	(4,916)	(3 777)	(4,572)	(3,387)
All other cropland not for harvest	(1,400)	(881)	(1,319)	(683)

Source: 1969 Agricultural Census. Vol. 1. Area Reports. Part 30. Kentucky. Section 1. Summary Data. June 1972.

Based upon the data in Table 2, cropland in the Cropland Not for Harvest categories accounted for nearly 67 percent of total cropland in farms in Kentucky. Acres reported as cropland pasture accounted for slightly over half of the total cropland base. The occurrence among the Class 1-5 Farms, that is, the more commercial operations, was also high. Among the 120 counties in Kentucky, cropland pasture as a percent of total cropland varied from 18 to 79 percent. In an attempt to discern any regional variations, the counties were grouped according to Land Resource Areas (LRA's) as defined by the Soil Conservation Service. 17/ The LRA's are delineated according to differences in soil, water resources, land use and type of farming, and climate. The six LRA's for Kentucky are outlined in Figure 1.

Counties in LRA 125, part of which are in the Appalachian range, for example, have considerably high percentages of cropland in cropland pasture than counties in LRA 134 at the western extreme of the state. One model to attempt to "explain" the reported variation in percent cropland pasture among Kentucky counties is in (1) where the percent

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17/ Austin, M. E. Land Resource Regions and Major Land Resource Areas of the United States. U.S.D.A. SCS. Agriculture Handbook 296. Dec. 1965.

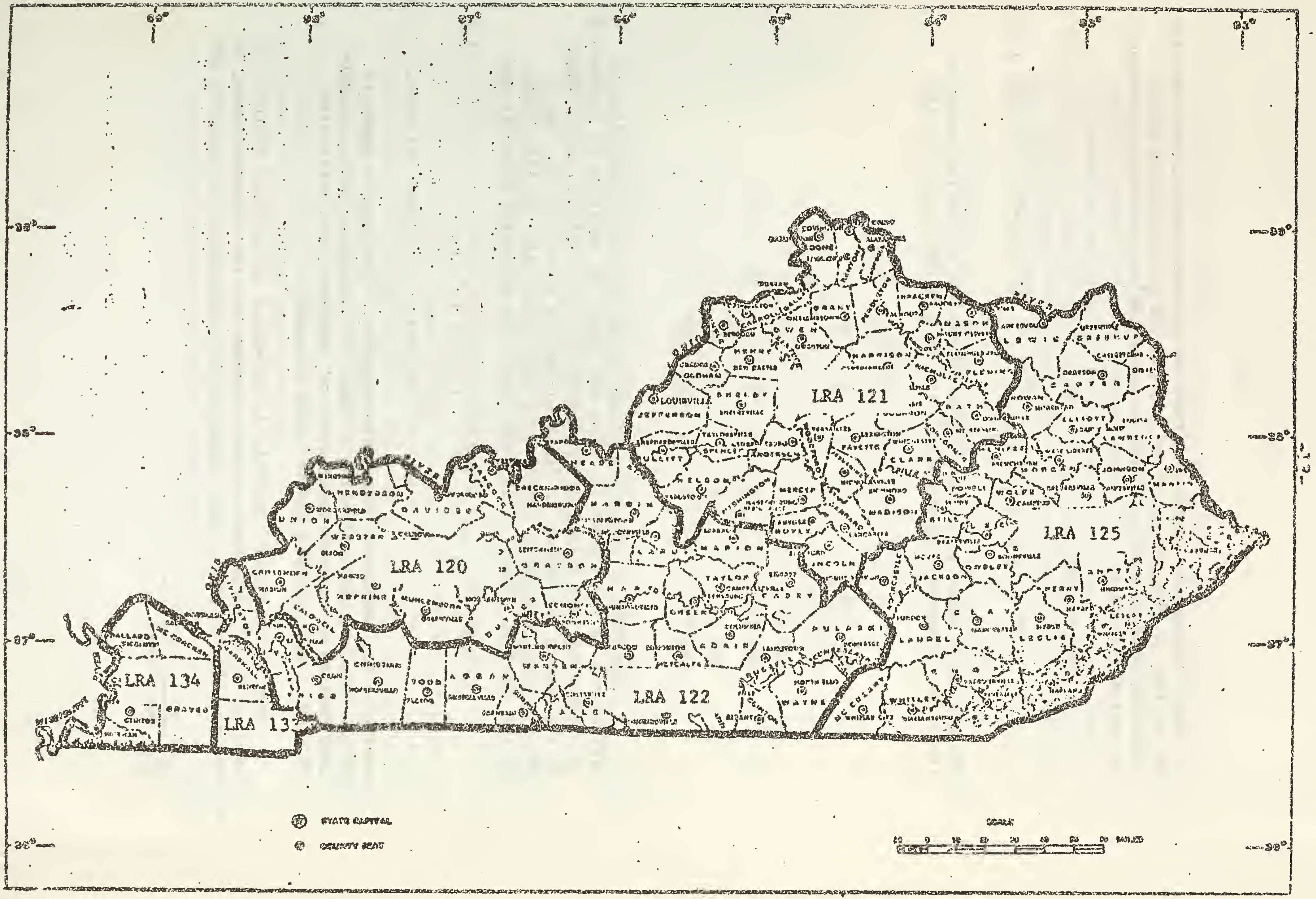

Figure 1. Counties Grouped by Land Resource Areas, Kentucky.

of total cropland in cropland pasture is expressed as a linear function of the LRA's. The six LRA s are represented by a system of dummy variables embodying any differences among LRA's, including differences in soil and climate.

$$CP\% = f(LRA_a) \quad (1)$$

$$= \beta_o + \beta_a LRA_a + \varepsilon_a \quad (a = 120\text{-}22,\ 125,\ 133,\ 134)$$

The system of dummy variables follows where LRA 122 in the center of the State is arbitrarily chosen as the base or reference LRA: 18/

	D_1	D_2	D_3	D_4	D_5
LRA 122	0	0	0	0	0
LRA 120	1	0	0	0	0
LRA 121	0	1	0	0	0
LRA 134	0	0	1	0	0
LRA 125	0	0	0	1	0
LRA 133	0	0	0	0	1

A procedure for weighting values of the variables according to differences in the number of farms per county is outlined in Appendix 2. Incorporating this weighting procedure, (1) is rewritten as (2) where N_i represents the number of farms in the ith county and ε_{ij} the unobservable, composite error terms associated with the ith county in the jth LRA. When (2) is quantified, the estimated model is non

$$(CP\%/N^{.5})_{ij} = \beta_o + \beta_n(N^{.5})_{ij} + \beta_j D_j + \varepsilon_{ij} \quad (2)$$

$$(i = 1, \ldots, 120) \cdot (j = 0, \ldots, 5)$$

sensical; the predicted values are negative. The problem seems to result from a double weighting in that CP% represents acres in cropland pasture divided by total acres of cropland, the latter also related to farm numbers and(or) size of county.

When the dependent variable is expressed as cropland pasture, in units of 1,000 acres rather than a percentage, the estimated model is in (3). Estimated standard errors of the regression coefficients are

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18/ See Figure 1.

in parentheses. Levels of statistical significance are designated as *** (1 percent), ** (5 percent), and * (10 percent). The variables in (3) account for about 68 percent of the observed variation in county acreages of cropland pasture when the values of all variables are weighted by the number of farms in respective counties. Based upon the estimated coefficients for the dummy variables in (3), only those conditions embodied in LRA 121 and LRA 125, represented by D_2 and D_4, respectively are statistically significantly different from LRA 122, the base or reference LRA.

$$(CP/N^{.5})_j = \underset{(.196)}{.2716} + \overset{***}{\underset{(.005)}{.0304}}N_j^{.5} - \underset{(.130)}{.0217}D_1 + \overset{***}{\underset{(.105)}{.4721}}D_2 \qquad (3)$$

$$- \underset{(.183)}{.2278}D_3 - \overset{***}{\underset{(.127)}{.5099}}D_4 - \underset{(.289)}{.4174}D_5$$

$$(j = 0, \ldots, 5) \qquad R^2 = .680$$

where: CP = Acres of cropland pasture, in units of 1 000 acres, in the jth LRA; and

N = Number of farms in the jth LRA.

Regional and state estimates of acres in cropland pasture can be derived from (3) for comparison with acreages reported in the Census. Consider LRA 120, for example, where $D_1 = 1$ and $D_2, \ldots, D_5 = 0$ and $N_1^{.5} = 129.9$. Substituting these values in (3) and collecting terms CP for LRA 120 is estimated as 545.3 (in units of 1,000 acres) as compared to 629.5, the Census acreage. After repeating this procedure for the other LRA's and summing, acreage in cropland pasture in Kentucky is derived as 4,000.2 compared to the Census acreage of 4,915.6.

Associations between changes in the number of farms and the incidence of cropland pasture can be estimated from (3). Substituting the values for LRA 120 into (3) and taking the first derivative with respect to N_1, $dCP/dN_1 = .1358/N_1^{.5} + .0304 = .0314$. Assuming total land in farms is constant, more farms would result in a lower average size of farm and vice versa. One farm in addition to the 16,875 reported for LRA 120 is estimated to be associated with a 31 acre increase in cropland pasture within the LRA.

Other explanatory variables can be hypothesized. The incidence of cropland pasture may be expected to be related to livestock numbers. A composite livestock variable, designated L, is defined as the number of cattle and calves plus horses and ponies, in terms of 1,000 head per county. Variable L could be disaggregated into individual components; a common denominator such as animal unit months would seem preferable. The estimated model incorporating L and the dummy variables is in (4). The coefficient for L is highly significant, and livestock numbers is an important variable in explaining or accounting for the observed variation among county estimates of acres in cropland pasture. This is, however, only an estimated association; no causality can be inferred from regression analyses.

$$(CP/N^{.5})_j = \underset{(.121)}{-.0657} + \underset{(.003)}{\overset{***}{.0091}}N_j^{.5} + \underset{(.096)}{\overset{***}{1.3485}}(L/N^{.5}) - \underset{(.078)}{.0259}D_1 \qquad (4)$$

$$+ \underset{(.064)}{\overset{***}{.3661}}D_2 - \underset{(.111)}{.0810}D_3 + \underset{(.086)}{.0533}D_4 - \underset{(.176)}{.0544}D_5$$

$$(j = 0, \ldots, 5) \qquad R^2 = .885$$

where: L = Cattle and calves plus horses and ponies, in 1,000 head, in the jth LRA.

Regional and state estimates of acres in cropland pasture are also derivable from (4). Using LRA 120 as an example where L = 385.8, cropland pasture acreage is derived as 661.9, compared to the observed acreage of 629.5. For the State, the estimated acreage is 4,751.2 compared to the reported 4,915.6. In comparison, the estimated State acreage from (3) was only 4,000.2.

The association between acres in cropland pasture and livestock numbers is estimated by the first derivative of (4) with respect to L. Since dCP/dL = 1.3485, a unit increase in livestock numbers 1,000 head, is associated with a 1.3485 x 1,000 = 1,348.5 increase in cropland pasture acreage. The converse also holds. The unit increase (decrease) would, of course, need to reflect a proportional increase (decrease) of livestock components similar to the proportion or percentage distribution of these components as reported in the Census.

Other variations are possible. A few of the counties in Kentucky are in SMSA's, Standard Metropolitan Statistical Areas. Because of high opportunity costs, cropland in these counties may be expected to be used relatively intensively. To estimate this association, another set of dummy variables was formulated where SMSA County = 1 and non-SMSA = 0. When the SMSA variable is added to the model in (4) the estimated coefficient is negative, the R^2 increases slightly to .897, and the other properties are essentially the same. Consequently, the estimated association between SMSA counties and incidence of cropland pasture in Kentucky is negative.

The occurrence of cropland pasture may be related to the type of farm. One plausible hypothesis is that the incidence of cropland pasture is higher for relatively small-scale, part-time, and(or) part-retirement farms. Some of these operations are expected to be in the process of phasing into or out of production with cropland being used less intensively. To estimate this hypothesized association, variable T is defined as the combined number of farms reported as Class 5 and 6, part-time, and part-retirement, in units of 100 farms. When the variables are again weighted according to the procedure outlined in Appendix 2, (5) is estimated. The sign of the estimated coefficient for the weighted T is negative. Consequently, based upon the county data for Kentucky, acres in cropland pasture and the number of farms

$$\begin{aligned}(CP/N^{.5})_j = {} & \underset{(.147)}{.1121} + \underset{(.008)}{\overset{***}{.0919}}N_j^{.5} - \underset{(.900)}{\overset{***}{8.2043}}(T/N^{.5})_j \\ & - \underset{(.111)}{\overset{**}{.2421}}SMSA + \underset{(.098)}{.0206}D_1 + \underset{(.084)}{.2709}D_2 \\ & - \underset{(.136)}{\overset{**}{.2924}}D_3 - \underset{(.106)}{.0537}D_4 - \underset{(.216)}{.1739}D_5 \end{aligned} \tag{5}$$

$$R^2 = .827$$

where: T = Total of Class 5 and 6, part-time, and part-retirement farms, in units of 100 farms, in the jth LRA.

embodied in T are negatively associated. Taking the first derivative of (5) with respect to T, a unit increase in T, that is, 100 farms, is associated with a 8,204 reduction of acres in cropland pasture.

Variable T likely embodies a number of other factors or influences such as average farm size, per farm average value of all machinery and equipment, and average age of operator. Based upon a matrix of simple correlations, T is highly correlated with these and other factors. These associations would help account for the relatively high R^2 derived for the relatively simple model (5).

The Census provides data for other variables. Farms are classified according to the tenure of operators, that is, full owners, part owners, and tenants. Let variable F represent the number of farms in each county operated by full owners. A positive association between F and acres of cropland pasture is hypothesized. Full owners may use cropland less fully than, for example, tenant-operators.

Cropland pasture does not seem to represent an intensive use of available cropland. Assume that the value of machinery and equipment is a proxy variable representing the intensity of cropland use among counties. This variable, M, is expected to be negatively associated with the incidence of cropland pasture. When variables F, M, and T are added to the model in (4), the estimated model is in (6)

$$
\begin{aligned}
(CP/N^{.5})_j = {} & \underset{(.108)}{.0443} + \underset{(.012)}{\overset{***}{.0601}}N_j^{.5} + \underset{(.125)}{\overset{***}{1.2464}}(L/N^{.5})_j \qquad (6) \\
& + \underset{(.471)}{.2231}(F/N^{.5})_j - \underset{(.772)}{\overset{***}{3.5678}}(M/N^{.5})_j - \underset{(1.29)}{\overset{***}{5.3510}}(T/N^{.5})_j \\
& - \underset{(.089)}{.0924}SMSA + \underset{(.077)}{\overset{**}{.1693}}D_1 + \underset{(.062)}{\overset{***}{.2635}}D_2 + \underset{(.103)}{.0358}D_3 \\
& + \underset{(.077)}{.0777}D_4 + \underset{(.157)}{.1002}D_5 \\
& (j = 0, \ldots, 5) \qquad R^2 = .916
\end{aligned}
$$

where: F = Number of farms operated by full owners in the jth LRA; and

M = Value of machinery and equipment, in units of \$1,000, on farms in the jth LRA.

Most of the estimated coefficients are highly significant. The standard error for F, the number of full owners, is very high relative to the estimated coefficient. F would be expected to be related to T. As noted earlier, Census data for a number of variables are expected to be interrelated. For example, the simple correlation between F and T, both weighted by respective farm numbers, is estimated as about .801. These interdependencies suggest the existence of multicollinearity among the independent variables. In this framework the effect of individual independent variables on the dependent variable cannot be isolated or segregated. Thus, the first derivatives between the dependent and independent variables tend to be not meaningful or at least suspect. Earlier models incorporated single independent variables along with the dummy variables.

To this point, acres in cropland pasture has been identified as the dependent variable. Recall that at the All Farms" level, individual acreages for the other Cropland Not for Harvest categories are not available but are combined in "Other Cropland Not for Harvest". Since summer fallow, idled cropland, and cropland in soil improvement crops represent different phenomena subject to differing decision-making factors, there is little merit in combining these cropland uses into a dependent variable in any modeling effort. If the focal point were cropland use among the Class 1-5 Farms, analyses could be conducted for these individual components of "Other Cropland Not for Harvest".

Limitations of Analyses

In interpreting any analytical results, several factors should be kept in mind. First, an evaluation of the quality of data should be attempted. Simply using the "only data" or "the best we have" may result in analyses and conclusions which are biased and misleading. The variability in the magnitude of land use data among major data sources was pointed out in Table 1. Even at the national level, considerable variation exists for estimates of cropland pasture and Other Cropland Not for Harvest. Substantially more variation would be expected at state and county levels.

The models developed in this paper reflect data availability. This simplified approach can only estimate associations among variables; causality between the dependent and independent variables cannot necessarily be inferred. Critical questions concerning the productivity of cropland reported as Cropland Not for Harvest and the economic and institutional circumstances under which cropland is shifted into and out of these uses cannot be even partially answered by analyzing published Census data. The basic question is whether or not this land is sufficiently comparable to Cropland for Harvest so that the former can be legitimately included in the cropland base. Researchers providing estimates of the cropland base and others using these estimates need to wrestle with this question. Taking a literal interpretation of the definitions as a justification for treating this land as cropland seems too convenient.

The opportunity costs of using cropland in the Cropland Not for Harvest categories are unknown. This land is, by definition, immediately usable as cropland for harvest. Yet, the matrix of factors causing decision makers to idle this land or use as cropland pasture is not discernable from the Census data.

Suggestions for Future Research

Any future research into the features of land in the Cropland Not for Harvest categories should be an outgrowth of a demonstrated need for same. Based upon the data in Table 1, considerable variability exists among sources generating these land use data. The reported magnitude of acreage in the Cropland Not for Harvest categories further suggests the need for more information on these land uses. Excluding acres summer fallowed, nearly 26 percent of total cropland reported in the 1967 CNI was identified as Cropland Not for Harvest. Among Class 1-5 Farms in the 1969 and 1964 agricultural Censuses, 25.7 and 20.4 percent of total cropland was in the Cropland Not for Harvest categories, respectively, after excluding acres summer fallowed. Acreages reported in the 1975 SRS JES, however, are substantially below the 1969 levels. The inclusion or exclusion of acreages of this magnitude in the cropland base has to have a strong impact on analyses of current and projected land use.

While wrestling with the question of "How much?", there are the related questions of "What type of land is it?" and "What determines its reported use?". The first question of "How much?" can be answered through surveys such as the SRS June Enumerative Survey. Data reliability at the state level could be improved by increasing the sample size, at least in states of major importance. Data generated by interviews with trained enumerators, as in the SRS JES, are preferable to those resulting from mail surveys. The former, however, are costly.

Insights into the question of "What is it" can likely be obtained through county SCS personnel. These individuals could make observations on soil type, topography, and other factors helping define alternatives to current land use. Answers to "What determines its use" requires an identification of the factors causing operators to allocate cropland to the Cropland Not for Harvest uses. This information can only be obtained through interviews with the decision makers. The SRS JES questionnaire is already lengthy. Also, the types of questions necessary for exploring decision making processes are not easily incorporated into the JES format. The best approach seems to be a second round of interviewing SRS JES respondents to get insights into the decision making matrix. There is, of course, an opportunity cost associated with the resources necessary to conduct this inquiry. There is also, however, an opportunity cost associated with not improving the understanding of these land uses. Analyses of Census data do not provide the answers.

Appendix 1. Estimated acres and corresponding standard errors and coefficients of variation for specified cropland uses in the ten production regions and the U.S., 1975.

Region	Summer Fallow Acres (1,000)	Summer Fallow Std. Error (1,000A)	Summer Fallow C.V. (%)	Cropland Pasture Acres (1,000)	Cropland Pasture Std. Error (1,000A)	Cropland Pasture C.V. (%)	Soil Improvement Crops Acres (1,000)	Soil Improvement Crops Std. Error (1,000A)	Soil Improvement Crops C.V. (%)	Idle Cropland Acres (1,000)	Idle Cropland Std. Error (1,000A)	Idle Cropland C.V. (%)
Northeast	19	4.7	24.7	469	46.9	10.0	142	38.7	27.3	757	71.0	9.4
Lake States	535	78.0	14.6	1447	130.3	9.0	151	38.6	25.6	945	106.1	11.2
Corn Belt	30	11.1	37.0	2759	205.3	7.4	120	39.7	33.1	695	84.8	12.2
No. Plains	16365	547.2	3.3	1523	160.6	10.5	105	33.7	32.1	521	89.4	17.2
Appalachian	4	2.5	62.5	1882	164.7	8.8	83	27.8	33.5	1210	97.0	8.0
Southeast	8	7.4	92.5	987	178.4	18.1	51	16.1	31.6	916	80.3	8.8
Delta	76	20.3	26.7	727	114.6	15.8	4	2.4	60.0	619	110.7	17.9
So. Plains	794	103.3	13.0	4853	667.0	13.7	46	25.6	55.7	2965	260.7	8.8
Mountain	9737	379.9	3.9	4249	1443.2	34.0	154	90.5	58.8	542	67.4	12.4
Pacific	3489	188.9	5.4	1943	320.7	16.5	8	3.8	47.5	604	205.3	34.0
U.S.	31054	704.8	2.3	20843	1670.3	8.0	864	124.9	14.5	9775	417.4	4.3

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a/ Adapted from SRS June Enumerative Survey, 1975.

Appendix 2. Procedure for Weighting Variables Derived from Census Data

The appropriateness of weighting variables based upon Census data used in regression analyses has both intuitive and statistical bases. In cross-sectional analyses of county data, one set of observations, for example, acres in various land uses and livestock numbers, is available for each county for each Census year. The counties, however, vary in size and in number of farms per county. For Kentucky, total land in farms varies from 6,091 acres in Martin County, LRA 125 to 344,116 acres in Christian County, LRA 122. Number of farms ranged from 50 in Martin County to 3,092 in Barren County, LRA 122. In aggregating county data for analysis of land use at the State level, such as the cross-sectional analyses in this paper, conditions in Christian and Barren Counties are relatively more important than those in Martin County because the former represent a larger proportion of the resources and area within the State.

Statistical theory provides a more persuasive basis for the weighting procedure. The discussion of this basis follows Rao and Miller. 19/ A simple regression model is expressed as a statistical model in (A-1) where subscripts ki denote the kth farm in the ith county. Among the 120 counties in Kentucky, Martin County, for example,

$$CP_{ki} = \beta_o + \beta_1 L_{ki} + \varepsilon_{ki} \qquad \text{(A-1)}$$

has been designated as i = 101 with k = 1, . . . , 50. CP and L represent acres in cropland pasture and livestock numbers, respectively. An error term, ε_{ki} is associated with the Census data reported for each farm. This potential error may result, for example, from the respondent misinterpreting the question on the Census form and (or) not correctly recalling or reporting information on his farming operation. The error term is not expected to have any systematic fluctuations. That is, the sign and magnitude of the error term are expected to vary randomly among reports from individual farms. This is, of course, one of the principal assumptions implicit in use of the Gauss-Markov Theorem for estimating models such as (A-1) by least-squares procedures. 20/ The error terms are also assumed to be drawn from or to be generated by a statistical distribution with variance σ_ε^2 When these assumptions are satisifed, the variance of the error variables is termed homoscedastic.

19/ Rao, P. and R. L. Miller, Alplied Econometrics, Wadsworth Publishing Co., Inc., Belmont, Calif., 1971, Chap. 5.

20/ See, for example, Draper, N.R. and H. Smith. Applied Regression Analysis, John Wiley & Sons, Inc., New York, 1966; and Johnston, J., Econometric Methods, McGraw-Hill Book Co., Inc., New York, 1963, Chap. 1.

Recall that the Census data are published for groups of farms at the county level and not for individual operations. While the assumption that the variances of the error terms for individual farms are equal seems plausible, the error variance of groups of farms cannot be the same unless the number of farms is equal for all counties. 21/ As noted earlier, the number of farms varies among counties in Kentucky. When (A-1) is summed across the k farms for each of the i counties, (A-2) is generated.

$$\sum_k CP_{ki} = \sum_k \beta_o + \beta_1 \sum_k L_{ki} + \sum_k \varepsilon_{ki} \qquad \text{(A-2)}$$

Letting N_i represent the number of farms in the respective counties, (A-2) is rewritten as (A-3).

$$CP_i = \beta_o N_i + \beta_1 L_i + \varepsilon_i \qquad \text{(A-3)}$$

The error term, ε_i is not homoscedastic but heteroscedastic. Estimating the coefficients in (A-3) by least-squares based upon the Gauss-Markov Theorem would not result in minimum variance and unbiased estimates of β_o and β_1. The variance term in (A-3) can be expressed as (A-4).

$$V(\varepsilon_i) = V(\sum_k \varepsilon_{ki}) = N_i \sigma_\varepsilon^2 \qquad \text{(A-4)}$$

Define a new error variable as $\varepsilon_i^* = \varepsilon_i/(N_i)^{.5}$ with variance, $V(\varepsilon_i^*) = \sigma_\varepsilon^2$ so that the variance of the error term across the i counties is equal to σ_ε^2. If (A-3) is reformulated in terms of ε_i^*, the assumptions implicit in the Gauss-Markov Theorem are satisfied and best linear unbiased estimates of β_o and β_1 are derived. In addition to the assumption that the ε_i^* are uncorrelated, the ε_i^* are further assumed to be uncorrelated with the independent variable(s). When the terms in (A-3) are divided by $(N_i)^{.5}$, (A-5) is developed. This procedure is used for

$$CP_i/(N_i)^{.5} = \beta_o(N_i)^{.5} + \beta_1 L_i/(N_i)^{.5} + \varepsilon_i^* \qquad \text{(A-5)}$$

weighting variables in the regression models developed in this paper.

21/ Rao and Miller, Applied Econometrics, pp. 79-80.

Appendix 3. 1969 Census of Agriculture Definitions of Variables Used in Regression Models.

Farm	A place of 10 acres or more with sales of farm products in 1969 of $50 or more. If less than 10 acres, sales totaled $250 or more.
Land in Farms	Acres owned plus acres rented or worked on shares less acres rented or leased to others.
Cropland Used Only for Pasture and Grazing	No further clarification was provided Census respondents. An "in house" definition not communicated to Census respondents was reported as, "The farm operators were to include all land used only for pasture or grazing that could have been used for crops without additional improvement, and all land planted to crops that was pastured before the crops reached maturity. All cropland used for rotation pasture and land in government diversion programs which was pastured was to be included. Cropland that was pastured before and after crops were harvested was not to be included." 22/
Cropland Used for Cover Crops, Legumes, and Soil-Improvement Grasses, but not Harvested and not Pastured	No further clarification was provided Census respondents.
Cropland in Cultivated Summer Fallow	All cropland that was plowed and cultivated or on which the growth of weeds was controlled through the use of herbicides but which was left unseeded for 1969 harvest for the purpose of conserving moisture. Include such cropland as cultivated summer fallow even if during 1969 it was planted to wheat for harvest in 1970.
Cropland Idle	No further clarification was provided Census respondents.
Class 5 Farms	Farms having sales of farm products of $2500 to $4999.

22/ Bureau of Census, Farms: Number, Use of Land, Size of Farm, p. 8.

Class 6 Farms	Farms having sales of farm products from $50 to $2499 and a farm operator under 65 who did not work off the farm 100 days or more in the Census year.
Part-time Farms	Same as Class 6 but with a farm operator who worked off the farm 100 days or more in the Census year.
Part-retirement Farms	Farms having sales of farm products of $50 to $2499 and a farm operator 65 years old or over.
Per Farm Average Value of Machinery and Equipment	Derived as estimated total market value of all machinery and equipment divided by number of farms reporting same. Census respondents were asked to estimate the market value of machinery and equipment kept (on this place) and used for the farm business in 1968 or 1969 regardless of ownership. The estimate was not to represent the replacement cost or the depreciated value of the machinery and equipment.